

Mach and Froude Numbers on Mars

Mars atmospheric global circulation models exhibit transonic jet streaks during northern winter, which motivates this study of the Mach number, Ma (the ratio of flow speed to the speed of sound), and Froude number, Fr (the ratio of flow speed to the speed of buoyancy waves), as a function of season and location. Two global reanalyses spanning Mars Years (MY) 24 to 32 are used as input, EMARS and OpenMARS. Area-weighted global means and standard deviations, and 5-year temporal means using the complete years MY 25, 26, 29, 30, 31, are compared. EMARS and OpenMARS show general agreement below $z \sim 50$ km, where the observational constraints are strongest, but can vary significantly at higher levels. Both reanalyses contain transonic jet streaks in every northern winter sampled. The Fr signal is roughly twice the Ma number signal, as expected where the temperature lapse rate is small compared to the dry adiabatic lapse rate. Mach numbers are similar in both reanalyses but show larger year-to-year variability in OpenMARS. Maps of standard deviations indicate a depression between the main peaks in Tharsis, and higher variability in Mare Boreum than Mare Australe. The main conclusion is that the atmosphere of Mars routinely operates in the compressible regime ($0.3 < Ma < 0.8$), unlike Earth. Preliminary results on Mach and Froude numbers in the lower atmosphere will be presented as well.